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ANALYSIS OF MULTIMEDIA
INFORMATION SYSTEMS
FOR THE U. S. COAST GUARD

by

Andrew C. Metcalf

March, 1992

Thesis Advisor: Dean Barry A. Frew

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Multimedia was found to be a positive development in information technology and is expected to be popularly accepted in very short order. The Coast Guard is not now implementing multimedia in its mainstream information processing functions, although several research and development projects involving multimedia are currently in progress. Recommendations are made for earliest evaluation of the new technology and some general implementation guidelines.

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Analysis of Multimedia Information Systems for the U. S. Coast Guard

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ABSTRACT

This is a descriptive study of multimedia information systems, their current and potential uses, benefits, and drawbacks to provide the basis for implementation of multimedia technology in the U. S. Coast Guard. Multimedia is generally considered to be a mix of text, graphics, sound, and static or full-motion video in an information system. In recent years, there has been a dramatic surge in the introduction of new multimedia products and the integration of multimedia with more conventional computing. These new applications include databases that use video images or audio recordings, teleconferencing, PC-based video production editors, and audio/music synthesizers, plus many more.

Multimedia was found to be a positive development in information technology and is expected to be popularly accepted in very short order. The Coast Guard is not now implementing multimedia technology in its mainstream information processing functions, although several research and development projects involving multimedia are currently in progress. Recommendations are made for earliest evaluation of the new technology and some general implementation guidelines.

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I. INTRODUCTION

This paper is an attempt to introduce the field of multimedia computing to the Coast Guard information systems manager who has not yet caught up with what may be the hottest new topic in computing. Multimedia interacts with virtually every aspect of computing, and in one way or another will probably affect anyone who works on a computer, if not immediately, then in the very near future. However, since so much of it is new, and because multimedia has, in the past, been considered mostly a toy, not for use in a working environment, it is possible that average systems managers are unaware of just what it is, why multimedia is important to them, and why they should be interested.

If technology is marketable or useable in any way, it will be adopted by commercial business and government offices. This is a demonstrable fact, one that gets proven again and again with virtually every new invention or technological achievement. In the field of information management, we have seen organizations almost immediately make use of innovations that make it easier, faster or more convenient for them to write, calculate, edit, communicate, or store the myriad of elements of information they need to process. At different times in history, thousands of new inventions have been adopted by government and business, including the: abacus, printing press, typewriter, adding machine, telegraph, radio, telephone, camera,

audio recorder, Ditto® machine, photocopier, television, telefax, calculator, and of course computer.

The use of computers in business and government represents an enormous leap forward in information processing. Data about personnel, or accounting transactions, or engineering calculations can be manipulated electronically, saving enormous quantities of time, money and numbers of personnel. Desktop computers have provided much more immediate and direct access to the information being handled, allowing the user to input, retrieve, or make changes to data personally. Simple text can be manipulated for spacing, justification, fonts, and special features (boldfacing, underlines, etc.). Graphics can be created, edited and added to documents. In fact, with laser and color printers connected, the full capabilities of a print shop and small publishing house can be encompassed on a desk top computer. Text and numbers can be stored in databases in almost any format imaginable, and then can be retrieved, sorted, indexed, compared, edited, and removed. Accounting, engineering and statistics programs provide the ability to do virtually anything with numbers and calculations that may be needed. In general, if something can be done with text or numbers on paper or in file systems, it can be done on a computer faster and more conveniently. All of these features can be and are commonly included into a business information system.

Recent advances in technology now incorporate sound, video and full-motion animation into a multimedia information system, giving the user even more power to help comprehend information. Multimedia has been hailed by some as the next phase

in the computer revolution, but the complexity and expense of mixing video and sound with text has kept the market small, up to now. Now, however, a number of different players are working together to make multimedia a cost-effective, transaction tool for business and government.

There is no doubt that multimedia is another tool that will be adopted by business and government almost as fast as new applications can be marketed. However, not every firm or government office will have the same needs for multimedia. Some businesses find that they can still get by using a typewriter and a calculator instead of a computer (in fact, in some regions many shopkeepers can still be found doing calculations on an abacus). Other businesses find themselves dramatically limited by the capabilities of their high-speed mainframe computers.

This thesis addresses just what multimedia is, what it can be used for and whether or not the Coast Guard needs multimedia. It should serve as an adequate basis for introducing information systems managers to this new and unfamiliar field[1], as well as providing some guidelines for its eventual implementation.

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[1]A glossary of multimedia terms and acronyms is included in the Appendix to help explain any unfamiliar expressions.

II. DEFINITION AND DESCRIPTION OF MULTIMEDIA

A. WHAT IS IT?

Multimedia is commonly defined as a combination of different content formats such as text, graphics, audio, motion video, still images and animation in an information system[2]. In effect, it is the merging of the diverse technologies of print, broadcasting, and computing.

Multimedia is not a single technology. It is not possible to simply purchase one integrated multimedia product like such as a spreadsheet or a word processing program. Peter Blakeney, manager of market support multimedia with the IBM Multimedia and Education Division of IBM U.S. says "The biggest misconception I've run into is that people think of multimedia as a unique *thing*"[Ref. 1]. Instead of a single all-inclusive multimedia package, what you are likely to be able to purchase is a word processing or spreadsheet program that accepts voice input to be included as annotated comments within a document, or a database program that records audio signals or visual images as data types[Ref. 2].

By the same token, there is no single market for multimedia, instead there are separate markets for multimedia services and applications. Schools are making increasing use of multimedia in education and corporations are using it in their

[2]This definition and many others for multimedia-related terms and acronyms are included in the Appendix, Multimedia Glossary.

training programs. Businesses are using multimedia in presentations, both within their organizations and to the public. For example, it is becoming common in home centers or hardware stores to see paint color-matching stations using an interactive PC-based multimedia system that is operated by the customers themselves.

> The technology is now here, the applications are here, the tools are here, and most of all, the problems for which multimedia offers unique solutions are finally rising to the top of the political and social agenda. Multimedia is no longer a solution in search of a problem. The problems have been identified. Now it is time for the solutions to be implemented.[3]

State and local governments are installing interactive multimedia kiosks in public locations for job search, car registration, and general information or help, and are developing a growing number of multimedia training programs[Ref. 3]. To help an ever-increasing number of people find employment, the Virginia Employment Commission uses an IBM multimedia system called the Automated Labor Exchange (ALEX). ALEX is a touch screen interactive videodisc application that allows individuals to perform their own job searches wherever a kiosk can be set up: libraries, malls, colleges, etc. The California Department of Motor Vehicles is installing systems to let people renew their registrations at their own convenience. Orlando, Florida installed a general information system for city services and schedules in a senior citizen center. Mercer Island, Washington put one in a 24-hour grocery store. Long Beach, California is one of many cities around the country to have installed IBM's trademarked 24-Hour City Hall, but they will be the first city to allow

[3]Rockley Miller, Editor and Publisher, Multimedia and Videodisc Monitor, at the Comdex/Fall 1991 event held in Las Vegas, Nevada 21-25 October 1991.

people to pay parking tickets and moving violations and even schedule a court date at the ATM-style machine set up outside their city court. The New York City Transit Authority developed a multimedia training program to provide health and safety training to its 40,000 employees. The program is run in three fixed and three mobile training centers with a total of 50 multimedia laserdisc-based systems.

A common view of multimedia production tools is that only highly-skilled professionals can use them, equating the process to a video or movie producer putting out a finished product for the masses. In truth, there are as many different skill levels required of multimedia as there are of any similar computer uses. Just as a specialist in the field can use a commercial spreadsheet product such as Lotus 123[4], Multiplan or EXCEL to produce a quality Decision Support System, replete automatic implementation of complicated macro commands, the same product can be used with relative ease by a rank tyro to create a useable office budget worksheet. Likewise with products such as Autodesk's Animator and 3D Studio, although fully capable of creating commercial advertising-quality productions, they can also be used by an imaginative office worker with previously created graphics or charts or with purchased clip-art images to add motion and imagination to a formal report. In fact, several

[4]Mention of specific commercial products in this report is not intended to be an endorsement of any kind. Any products identified by name are included to provide an example of a certain category of product that is currently sold on the open market or to illustrate the availability of such a product.

corporations are doing just that for their stockholder meetings or public presentations[5]. There will always be a distinction between the levels of professionalism required for producing multimedia products, but the same distinction does not exist among the users. The vast majority of potential multimedia users will never have any use for editing and production facilities. They will instead be the ones who sit down in front of a computer terminal and operate a training program or an interactive visual introduction to a new facility. Or, they might simply retrieve an audio or video record from a database for use in another application.

B. CURRENT USES AND APPLICATIONS

Virtually every type of computer platform can now support audio capabilities. Apple's Macintosh (The Mac Classic and Mac LC) have been shipping with installed microphones since October 1990, and Macintosh applications are increasingly supporting sound as a data type. PC's have a variety of add-on boards such as Artisoft's Sounding Board which can work under both DOS and Microsoft Windows to let you create voice files. The new series of RISC processor workstations and personal computers such as the IBM RISC System/6000 and the Silicon Graphics IRIS INDIGO and IRIS Power Series either come equipped with microphones and audio I/O capabilities or offer it as an easily installed option to be used under their proprietorial versions of the UNIX operating system. Networks have not been forgotten either

[5]The Coast Guard Academy Engineering Department provides us with an excellent example of a non-professional use of these products in their 3-D animated walk-through movies. A description of their project can be found in Chapter 3.

since both Artisoft's LANtastic network operating system and Futura's Right Hand Man groupware program support the Sounding Board for audio I/O.

The standard for defining how electronic musical instruments communicate with each other and with a computer is MIDI (Musical Instrument Digital Interface). The MIDI standard, developed in 1983, is essentially a digital communications protocol that has been adopted by virtually all major manufacturers of electronic musical instruments. A MIDI interface translates software commands and parameters into a language that is recognized by MIDI devices.

In addition to professional (or even amateur) musical production, MIDI-equipped personal computers, with the appropriate software, are also being used as efficient--and infinitely patient--instructors. Although virtually all commercially available MIDI software is geared toward musical instruments, MIDI technology can be used for any audio purpose that requires accurate control of tone, volume, and pitch. Computer language training programs are in the works, and possibilities exist for such esoteric uses as training mechanics to recognize the normal and abnormal sounds of jet engines. Since MIDI is based on data rather than digitized sound, it is a very efficient means of storage. Consequently, you can store hundreds of complex MIDI files in the space required for a single digitized song.

Videophone and video-teleconferencing, another aspect of multimedia, is now a reality. Several manufacturers are offering the capability including IBM who demonstrated their Person to Person two-way video conferencing at Comdex/Fall 1991. PictureTel Corporation is also jointly marketing with IBM their own technology for

full-motion, full-color dial up video conferencing over digitally switched 56 Kbps or 65 Kbps telephone lines.

Other applications currently on the market that fit within the multimedia definition include dozens of graphics presentation programs such as Harvard Graphics, drawing programs such as Corel Draw, and the graphics animation programs such as Autodesk's Animator or Animator Pro or MacroMind's Director for the Macintosh.

C. MULTIMEDIA PLATFORMS AND EQUIPMENT

Just what is it that makes a computer a multimedia platform? Although several manufacturers are selling multimedia-specific computers (including IBM and Tandy), you do not have to choose between a regular computer or a multimedia computer[Ref. 4]. The differences are only in the features or accessories either supplied with the computer or added on to tailor it to your needs. As mentioned already, some models of Apple's Macintosh are already equipped for audio and the new Quick Time Motion Picture Production package makes their System 7 operating system fully multimedia capable. Commodore's Amiga computer was originally designed to handle the multimedia basics of color graphics, animation, video, and sound. IBM's RISC System/6000 advertises graphics speeds of 800,000 vectors per second, 400,000 3D vectors per second and 20,000 Gouraud-shaded triangles per second[Ref. 5]. Hewlett Packard RISC machines offer similar performance, and though the Sun SPARCStation workstations were not originally designed with

high quality graphics in mind, they are being enhanced, and options are being offered that bring them up to currently expected levels of performance.

The new MPC (Multimedia Personal Computer) standard sponsored by Microsoft, Tandy, and a host of other hardware and software manufacturers through the Multimedia PC Marketing Council[6] defines the following minimum standard requirements for multimedia personal computing:

- A 386SX or higher processor
- 2MB of RAM
- 30MB hard disk
- VGA or VGA+ video display
- Two button mouse
- 101 key keyboard
- Serial and parallel ports
- MIDI I/O port
- Joystick port
- Headphones or speakers connected to the computer system
- Audio board with 8-bit DAC, 8-bit ADC, music synthesizer, on-board analog audio mixing capabilities

[6]The Multimedia PC Marketing Council is a subsidiary of the Software Publishers Association, and is made up of ten hardware vendors: AT&T Computer Systems, CompuAdd Corp., Creative Labs Inc., Media Vision, NEC Technologies, Olivetti, Philips Consumer Electronics Co., Tandy Corp., Video Seven, and Zenith Data Systems, and one big software company: Microsoft. Each member company has a seat on the board of directors, as does the Software Publishers Association.

- A CD-ROM drive with CD-DA outputs, sustained 150k/sec transfer rate without consuming more than 40 percent of CPU bandwidth in the process, and average seek time of one second or less
- Systems software compatible with the applications programming interfaces (APIs) of Microsoft Windows 3.0 with Multimedia Extensions 1.0 or later.

The system described may not be capable enough for many multimedia applications or for development tools. For example, Autodesk's Animator Pro requires a 386 or 486 processor and 4MB of RAM and their 3D Studio requires a math coprocessor[Ref. 6], but the MPC standard was designed to be sufficient for an average classroom type of multimedia training. It is also worth noting that these requirements were written around the Intel PC chip architecture. Obviously Apple, Commodore, and the RISC system manufacturers would recommend different configurations.

IBM's new Ultimedia version of their PS/2 Model 57SX computer demonstrates their position that the MPC specifications are set too low for serious multimedia computing[Ref. 7], and IBM does not endorse the MPC specification. Their new multimedia-specific computer includes an Intel 80386 chip enhanced with a built-in cache and optimized CPU instructions to speed up the processor, 4MB of system memory standard, 80MB hard disk, 2.8MB floppy disk drive, IBM's own XGA graphics capability, CD-ROM XA (DVI compatible), 16-bit audio sampling, MIDI-out, and 16-bit ADCPM compression and decompression. IBM also sees its OS/2 2.0 as the superior multimedia environment because of its 32-bit multithreaded capabilities and the ability to bus-master devices. The new Ultimedia is being shipped with OS/2

2.0, and though it will run Windows 3.0 with Multimedia Extensions, it is designed to run Windows under OS/2.

III. CURRENT STATUS OF MULTIMEDIA IN THE COAST GUARD

A. GENERAL STATUS

A single sentence can sum up the present degree of implementation of multimedia in the Coast Guard: There is currently no set policy in the Coast Guard specifically addressing the use of multimedia technology. However despite a lack of a policy statement, a few mutually independent projects in the field are developing or utilizing some aspects of it.

Although the fact that there is no present policy appears to be a negative statement, this does not necessarily indicate a problem, since it also reflects the present status with regard to multimedia within the majority of government agencies and private corporations today. Whether the Coast Guard *should* be using multimedia, and to what extent, will be addressed in Chapter 6. This current low use of multimedia would only constitute a problem if it reflected an overall attitude of ignorance about the field or indifference to it by cognizant offices. Ignorance is apparently not a problem since there are presently several separate projects underway using multimedia techniques. Also, considering the amount of development work of new technology throughout the Coast Guard, indifference does not appear to be a problem. According to the office of Command, Control, and Communications (G-T)[Ref. 8], one problem currently being addressed is the need for fusion of the wide variety of data requirements at command centers. This should include integrating image data

transmissions with existing data streams into a cohesive product retrievable on a single system. A general statement about the incorporation of such new technology is addressed in the following paragraph of a Tentative Operational Requirement (TOR) for Command Centers being reviewed within (G-T):

> Threat. Coast Guard's primary threat is obsolescence--whatever is fielded today will be overtaken by mission change in five years if it isn't highly flexible and modular. This is compounded by rapid technological change in the communications sensor and decision support areas--we wish to position ourselves to be able to rapidly take advantage of new technologies that offer improved effectiveness and decreased manpower costs.[Ref. 8]

The Coast Guard is apparently taking the development of information management technology quite seriously.

B. ONGOING PROJECTS

This section provides a description of several representative applications of multimedia currently underway within the Coast Guard.

1. ADVICE, ADVanced Image Communications and Enhancement

A primary feature of a multimedia application is the delivery of video images within a computer information system. Because of its major operational field of law enforcement, the Coast Guard makes extensive use of photographic information both for developing intelligence and actual enforcement/prosecution. However, due to the distances between the remote locations in which the cutters and aircraft operate, the delay in transmittal or delivery of this photographic information is often excessive.

The Coast Guard R&D Center initiated the ADVICE research project in December 1989 as part of the Comprehensive Law Enforcement Project to investigate potential benefits of near real-time (delays on the order of a few minutes) transmission of video images between operational Coast Guard units. Project sponsors are the headquarters offices G-OIN (Intelligence) and G-OLE (Law Enforcement). Due to the strong interest by diverse departments throughout the Coast Guard, a steering committee was formed in November 1991 and is headed by G-TTO (Command, Control, and Communications). The goal is to introduce ADVICE into everyday Coast Guard use in about 1½ years[Ref. 9].

A description of the background and purpose for this project is explained in the introduction to the Evaluation Plan Development[Ref. 10] written by Sandia National Laboratories for the Coast Guard in September, 1990. This report stated that the Coast Guard had identified a need to improve the methods it uses to handle intelligence information, especially photographic intelligence. It further claimed that recent advancements in electronic still imaging devices could be integrated into the Coast Guard's photographic operations, thereby potentially greatly increasing their intelligence gathering capabilities.

The Coast Guard is proposing to configure an Intelligence Processing System (IPS) which employs electronic still imaging for intelligence gathering and processing operations. The requirements for this project included the capability to capture high-resolution still images from ship and aircraft platforms with hand-held devices, and to transmit the digital images over VHF, HF, satellite and land-line links.

Although secure transmission was not included in the testing it was to be considered in planning for actual implementation. A further requirement was for the maximum compatibility with existing CG communications equipment. Finally, the equipment at the ground stations and on the operational units was to be easy to use; the user interface should not be complex--in order to keep the operator responsibilities at a minimum. These requirements are important for future consideration, since they incorporate many key features of security, useability and compatibility.

Many different hardware configurations were evaluated and eventually five DVIT (Digital Video Imaging Terminal) image transmission systems made by Harris - 3 base stations and 2 portables were purchased[7]. These systems are customized AT compatible computers which can grab, enhance, and transmit still images. Once the Harris equipment was chosen, peripherals were selected mostly for their compatibility with the Harris system. The still video cameras selected were the Sony MVC-5000, Sony MVP-660, the Kodak Hawkeye II High Resolution Camera accessory with a Nikon F-3 Camera, and the Panasonic AG-ES10. Other equipment included the Mitsubishi CP-200U Color Printer, and the Howtek Scanmaster II and Sharp JX 300 scanners.

The systems were tested in the Seventh District (Florida and the Caribbean), the busiest law enforcement district for the Coast Guard with a mixed

[7]The initial deployment of this equipment was scheduled for early 1991. However, due to unforseen demands on Harris Inc. (the primary contractor for DOD for electronic imaging/ transmission support for Operation Desert Shield/Dessert Storm), the Coast Guard purchased equipment was not available until May, 1991.

level of success.[Ref. 11][Ref. 12] Further testing was conducted in the Seventeenth District (Alaska and vicinity) on units of both D-17 and Pacific Area.[Ref. 13] Results here were positive, promoting interest in purchasing image transmission equipment as soon as possible.

In addition to sponsored testing, actual operations of the ADVICE system have been carried out aboard the polar icebreakers USCGC Polar Star (WAGB-10) and USCGC Polar Sea (WAGB-11). The Polar Star conducted operations with ADVICE during a deployment in the arctic from August through November 1991. Although problems were encountered with compatibility between transmitters and receivers, the system proved useful in ice operations[Ref. 14]. The Polar Sea departed on Operation Deep Freeze '92 in November, 1991 with the ADVICE system installed, again for operations vice testing. The Polar Sea is not due to return from Antarctica until the spring of 1992.

2. Coast Guard Academy 3-D Animated Site Walk-Through "Movies"

In 1990, the Department of Electrical Engineering at the U. S. Coast Guard Academy in New London, Connecticut initiated a series of projects that use Computer Aided Design (CAD) 3-D modeling teamed with a graphics enhancement program and an animation program to create moving, walk-through presentations of several different workspaces in Coast Guard units. The animation feature helps define these projects as multimedia. This concept presents an excellent example of the imaginative, non-

traditional uses for computers that has provided the impetus for development of multimedia.

One of these movies covers the bridge of the 270' Famous Class Cutter[Ref. 15], and a second movie covers the Combat Support Center of the same cutters[Ref. 16], both were sponsored and funded by the COMDAC (Command Display and Control) Support Facility in Portsmouth, Virginia. Two additional movies cover the Vessel Traffic System (VTS) Valdez[Ref. 17], and the Kodiak Command Center[Ref. 18], both sponsored by Coast Guard District Seventeen (t) in Juneau, Alaska. A fifth movie encompasses the entire 120' Heritage Class Patrol Boat[Ref. 19], sponsored by Coast Guard Headquarters Office of Acquisition, WPB Project Manager (G-AWP). According to Captain Benjamin Peterson, head of the C.G. Academy Department of Electrical Engineering, this series of projects is a continuing operation.[Ref. 20] Future walk-throughs are in progress or are planned for additional Coast Guard units, including the District Seven Command Center in Miami, Florida.

The movies were created by modeling the spaces as three dimensional wire frame diagrams with the Autodesk AutoCAD program, then enhancing the graphic images with Autodesk's AutoShade package by shading and coloring the solid objects. Variations of the renderings were made by altering the viewpoint slightly, then these consecutive renderings were strung together into a filmroll. The filmroll was developed with Autodesk's Animator program using cel animation (frame-by-frame) techniques for cartoon style animation. All of the computer work on these projects

was performed at the Coast Guard Academy by cadets in their final year (First Class) on a Compaq DeskPro 386/25 computer).

The movies provide a basis for training or familiarizing new personnel assigned to the commands or for those coming in for temporary periods such as technical representatives and for planning and designing potential modifications to the workspaces. The movies provide 3-D portrayals closer to "real-life" than blueprints or similar technical diagrams and are easier to interpret by the viewer. CAD-based graphics maintain the precision and accuracy of the former method. Portable presentations like these are especially useful for afloat units that may be underway or away from homeport for long periods. Personnel reporting aboard can already be familiar with the layout and facilities.

3. Innovative Training Systems for Spill Response (Computer-Based Interactive Video)

In October 1991 the Coast Guard Research and Development Center in Groton, Connecticut contracted with Analysas Corporation of Washington, DC to develop a prototype computer-based interactive video training system for oil and chemical spill response. The sponsoring command is the Coast Guard Headquarters Office of Marine Safety, Security and Environmental Protection (G-M). The intent of the project is to investigate the feasibility of using multimedia training techniques to improve the current training procedures for personnel responding to catastrophic oil and chemical spills. G-M needed a responsive, personalized (interactive) training

program unique to their own field. They funded this project first to determine if such a training method was practical, and then to actually develop the eight hour course. According to Ivan Lissauer, the program manager at the R & D Center, there is currently "no advanced video disk interactive program in the Coast Guard--anything that's out there that we don't use now is what we'd like studied"[Ref. 21]. The following descriptive quote is part of the technical abstract for the project.

> Research will focus on developing a computer based interactive video (CBIV) training system. This system will use performance based training methodology to present state-of-the-art spill response information to personnel who will use the system at their own pace. Computer based examinations will be included to ensure the effectiveness of the training program. The CBIV training system will be flexible to allow updates of new spill response technology. It will also be capable of training large numbers of people throughout the nation, and it will represent cost savings over classroom training programs. Phase I will be a feasibility study. Phase II will be the development and testing of a prototype.[Ref. 22]

The interactive video training project is scheduled to last about six months, and when complete G-M will decide whether or not the concept has been proven feasible and if they want to go ahead with production. Lissauer[Ref. 21] also stated that once the R & D Center proves that a concept is practical for one specific use or project, it almost invariably gets adopted by other offices/commands and adapted for other uses throughout the Coast Guard. So, it is to be expected that, if it is successful, this project will be followed by similar interactive video training courses within the Coast Guard.

IV. OBSTACLES TO IMPLEMENTING MULTIMEDIA

Multimedia may be the hottest topic in the computer industry today, but before it can be fully developed and integrated into the mainstream of workspace computing, several obstacles need to be overcome in the areas of data compression, bandwidth restrictions, processing power, and representation techniques of multimedia in databases. Until recently, multimedia on a desktop computer or workstation was just a dream because of the enormous processing power and memory required for video and audio manipulation. Now, however, almost all of the current crop of computers can handle some aspects of multimedia to one extent or another, but the fullest implementation requires some very special characteristics and equipment. Some multimedia applications have problems resulting from the depth of information that is associated with an image or audio file. This chapter will discuss inherent problems with multimedia, and the current level of solutions.

A. HOW MUCH DATA IS ENOUGH?

The most immediate difficulty in implementing a multimedia system has been the huge amount of data that need to be captured, stored, processed, and transferred. Consider, for example that a single digitized video frame can consume well over half a megabyte (MB) of storage. A standard television picture in the U.S. (NTSC format) is transmitted at a speed of 30 frames per second (fps). So, one second of digitized

video would require a minimum of 15MB (and possibly closer to 20MB) of storage. To capture and digitize a simple ten second sequence would require nearly 200MB.[Ref. 23][Ref. 24] That degree of memory use without data compression is obviously unacceptable from the position of space requirements. When typical microcomputer data transfer rates are considered, the problem gets more complex.

Since most computing in the Coast Guard is done within networks[8], bandwidth (throughput) becomes a critical issue. Even on LANs without multimedia applications, crowded circuits are becoming common. Multimedia files are predominately bit-oriented instead of the more familiar, character-oriented, alphanumeric files. A single 8.5 X 11-inch page of black and white text, that might take up 2 kilobytes (KB) of storage as characters, requires 1.2 megabytes as a graphic image. For entire files with many graphic images or even video sequences, there will be billions of bits to transfer instead of thousands of characters. Video has too many variables to pin down to a set figure, but depending on the compression technique used and the resolution of the image, playing compressed video over a network can use anywhere from 150KB to 2MB per second. On a typical 10 megabits-per-second (Mbps) Ethernet or 16 Mbps Token Ring network, that kind of data transfer can quickly overload a network.

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[8]Although standalone versions of the Coast Guard Standard Workstation (CGSW) are available, the CGSW is primarily a LAN component. The original C3 units were designed with the intention of connecting an entire office or command to the same file server, and each change or evolution since then has continued that concept.

Before addressing the data compression problem, developers of disk-based digital video had to make some compromises. Image sizes were limited, frame rates were reduced, the number of colors used got trimmed; all combined to reduce the storage needs to less than 100KB per video frame. That still adds up to more than 1MB per second. So various types of compression are used to reduce the file size even more.

B. IMAGE COMPRESSION TECHNIQUES AND STANDARDS

Compression techniques vary widely in the algorithms and other procedures used to reduce the amount of data required to represent an image. The following subsections discuss the primary distinguishing characteristics of the four basic standards that are currently the biggest factor in desktop multimedia computing.

The first choice to be made is whether or not the uncompressed (decoded) image needs to be an exact reproduction of the original, and if not, just how much resolution can be lost and still be acceptable. Most experts agree that some loss of resolution is acceptable in virtually every application, and in some cases--such as teleconferencing--as much as 95% of the original data can be discarded and still retain enough quality to keep the participants comfortable[Ref. 23][Ref. 24]. A lossy compression technique is used to achieve a high compression rate where exact reproduction is not deemed necessary. With lossy techniques, once the original data set is compressed, it can never be fully recovered. However, it results in a much higher compression ratio than the lossless methods often used in data-file compression.

Algorithms used in lossy techniques base the reduction on quantizing[9] the data values. Only a small number of bits are used to represent the entire data set. With this technique, as used in JPEG and MPEG, the greater the number of bits that are used--the greater the final resolution will be and the closer the representation is to the original image. The application in use determines the minimum number of bits needed for an acceptable image. As mentioned above, video teleconferencing requires a higher compression ratio and accepts a lower quality image (the new Px64 standard is designed specifically for videophone and teleconferencing), while in a medical imaging application, such as Ray-Base which stores and manipulates X-ray files, the reconstructed image needs to be as close to the original as possible, leading to a very low compression ratio. Further reduction can be achieved by using motion estimation and compensation to take advantage of the temporal redundancy in full-motion video (replication of much of the information from frame to frame) to reduce the number of bits used to represent following frames.

Another decision is to determine whether or not the encoding and decoding must be accomplished by the same equipment. For example, Compact Disc Interactive (CDI) and Digital Video Interactive (DVI) techniques take advantage of the fact that most user interaction with multimedia will be performed in a different location than that used to author the material. Hence, one set of equipment at the publishing house

[9]See the Appendix for definition.

can be equipped to compress the data, while the receiving units in the field need only to be able to decompress the data.

The four basic compression standards accepted today are described below[Ref. 23], but there is no reason to assume that one will eventually be adopted exclusively over the others. Each has its strengths and weaknesses, and most of the differences lie in the type of applications for which they are designed. With today's windowing schemes and multi-tasking operating systems, it is conceivable that all four could be in use during the same session: a teleconference in one window (Px64), another window giving access to an image database using JPEG stills, yet another window running a motion video training sequence using MPEG, and a final window open to an optical disk reference library using DVI technology.

1. DVI®

DVI (Digital Video Interactive) was introduced in 1987 by Intel as a set of proprietary algorithms to be run on a Very Large Scale Integration (VLSI) chip set. DVI offers both still image and motion video modes. It is most suited to the author-publishing paradigm, where the content is authored in one place and distributed, on CD-ROM, to a variety of users. The increasing use of CD-ROM and the proliferation of "multimedia computers" supplied by OEMs leads to a large market for DVI in desktop computing. Intel is no longer promoting their proprietary algorithms in competition to standardized ones, instead they are now offering their DVI technology as a general purpose chip set that can be programmed for a variety of different compression algorithms (including, of course, their own). The current version can

encode and decode still images using DVI modes and JPEG. Motion video is supported in asymmetric PLV mode for CD-ROM use, and in symmetric RTV mode. Intel promises that the next generation of DVI technology will also support Px64 with future versions also including MPEG.

2. JPEG

The Joint Photographic Experts Group is a standard for still image compression. Its algorithms define intraframe compression procedures. However, since they do not include procedures for interframe compression (compressing between frames) like MPEG, the level of compression is less for full motion video. It is still appropriate, though, for a number of applications such as imagebases, color fax, digital cameras and printers. Since the standards have been finalized for several years, and since JPEG codec[10] chips are easily available it has a fairly widespread acceptance and is being used as an interim solution for motion video compression until MPEG standards are finalized and chipsets are readily available.

3. MPEG

This standard for full-motion video is relatively new. Although, with only minor exceptions, the video-coding portion of the Moving Pictures Experts Group standard has been frozen since September 1990, the ISO balloting and acceptance was accomplished November 1991, and it may be another year or two before it is widely adopted. With its ability to do interframe compression as well as intraframe, it is

[10]See the Appendix for definition.

more suited for full motion than JPEG. It is designed to provide a 3 to 1 improvement over JPEG compression ratios (for motion video) and includes specifications for synchronized audio. Its uses include such activities as downloading video from a satellite, or storing motion video segments in a database.

4. Px64

Also known as the CCITT recommendation H.261, this standard is designed around 64-kilobit per second transmission channels (the P stands for a number times 64 kbit channels over a wide area network) for use in videophones and teleconferencing applications. Like JPEG, the Px64 standard has been finalized and accepted by ISO. This technique also recognizes temporal redundancy in motion video and compresses accordingly, but much more ruthlessly even than MPEG, resulting in greater compression but less fidelity to the original (very low resolution comparatively).

C. PROCESSING POWER

Creating images used in multimedia is a complicated process that requires tremendous computing power. For example, one function that is included in a number of compression algorithms, called the discrete cosine transform (DCT), requires 896 additions and 1024 multiplications to transform a single 8 by 8 pixel image block, using a matrix multiplication algorithm. There are 1320 of these 8 by 8-pixel blocks in the MPEG standard image format (e.g., 352 by 240 pixels). They require about 2.5 million arithmetic operations to complete a single image DCT. At the NTSC format

speed of 30 fps, a processor must continuously perform 76 million arithmetic operations per second.[REF. 24] Other formats or larger images can require four times more computing power just for the DCT. Motion estimation and compensation techniques to exploit temporal redundancy in compression can further increase the amount of computational processing required by a factor of from three to ten.

In general, the capability of handling approximately one billion operations per second (BOPS) is required for real-time image compression and computing operations. Current CISC and RISC processors can not be expected to handle that by themselves and still maintain normal computing functions. The most practical solution to this is the use of a separate processing unit to perform these functions for a multimedia system.

Presently, separate processors are being provided by means of an adjunct or add-in board to the host computer, but they can soon be expected to be built into the motherboards. Much development work is currently being done on fixed-function and programmable chips to supplement host processors for multimedia applications. Specific architecture and design of these special purpose processors is beyond the scope of this thesis. Several different manufacturers are already supplying chips and boards to fill this need, and a great deal of R & D work is being done to further improve components.[11]

[11]A good description of the functions performed, and the types of chips being produced, plus several examples of specific chips and their manufacturers can be found in [Ref. 24].

One such open-architecture programmable chip used in video applications familiar to most computer professionals is the Intel i750 series. An example of add-in boards available now for mainstream desktop multimedia use are the ActionMedia® family (which incorporate the i750 chips developed jointly by Intel and IBM). They provide DVI compatibility and are designed to deliver full-screen, 30 fps, real-time digital video for multimedia applications. Plus, they support algorithms that handle sound and still images. A separate module can be added to the delivery board to capture analog video and audio signals then convert them into digital information and pass the data to the delivery board.

D. SOLVING THE BANDWIDTH PROBLEM

Very high data transfer levels required by multimedia, such as those involved in bit-mapped images, dramatically increase the load in a network environment. When networks start handling video, a new set of problems develop due to the nature of the data itself. Most network users are familiar with situations where programs slow down, or take excessive amounts of time to transfer data when a network starts to overload. In this situation, the only adverse effect noted is just the time delay. The text output looks the same whether the transfer took three seconds or thirty seconds. However, when a video file gets delayed, or starts to break up (called artifacts), the file rapidly becomes unusable. An image is meant to be viewed as a whole and interpreted as a single coherent entity by the viewer. Video compression techniques are one way of reducing the load on the network, but they are not a complete solution.

In fact, until more widespread use of video applications are seen, it may be years before transmission of video data over networks becomes a recognized problem.

Multimedia, however, does not necessarily mean motion video. Several existing software programs already make use of an item called a compound document which contains voice and images appended to text. One example of this is the program called Image-Enable Notes jointly produced by Eastman Kodak and Lotus Development Corporation which allows you to scan an image and attach it to a Lotus Notes file, so a photograph or scanned document can be sent along with whatever E-mail message is generated in Lotus Notes. Additionally, various versions of voice E-mail already exist, and several new word processing or spreadsheet packages are being developed that will allow the user to append voice comments to a document, with video links coming next. All of these applications require more throughput in a network, either by reducing the data transferred with compression techniques as discussed above, or by increasing the capacity of the network itself (high-speed LANs).

There are presently two primary options commercially available in high-speed (100Mbps) LANs. One is a variety of products based on the Fiber Distributed Data Interface (FDDI) standard and the other is the proprietary Thomas-Conrad Networking System (TCNS). TCNS is not compatible with FDDI products, but it uses standard Arcnet drivers so it can be easily integrated into Arcnet LANs and is normally cheaper (a TCNS card runs about 1/3 the cost of an FDDI card). FDDI, of course is a

recognized standard[12]. Both products are designed to run over fiber-optic cabling, which necessarily increases the cost of a network enormously[13] over comparable copper wiring.[Ref. 23]

Because of the high cost and added complexity of connections, fiber optic cable is most commonly used as a network backbone, with the less expensive (and slower architecture) shielded twisted pair (STP) or coaxial cabling being used to connect desktop nodes to the backbone. Fiber, however, is no longer the only method of achieving the 100Mbps speed, although the STP alternative is new and not yet readily available. In May 1991 a group of five leading vendors announced and published an open, interoperable method of transmitting data using the FDDI interface over STP[14]. This method can be especially useful for those installations with an existing STP cabling plant, but would immediately put an upper speed limit on a network. Fiber has the capability of greatly exceeding the FDDI standard and potentially transmitting up to a gigabit (GB) per second. Copper wire can not achieve that level of performance. A gigabit may seem excessively fast now, but the past decade has already shown how quickly limits get exceeded.

[12]Originally developed by ANSI and issued in several sections in 1989 and 1990, then adopted by ISO in 1990 as ISO 9314.

[13]The difference in cost will depend primarily on the number of connections to be made. Fiber cabling itself is only about 1½ - 2 times the price of coax cable now, but connections into the fiber can run as high as $1000 each.

[14]The vendors were Advanced Micro Devices, Chipcom, DEC, Motorola, and Synoptics. Their announcement was accompanied by a demonstration of the interoperability of their individual components.

WANs have a related difficulty called the local loop problem. Here, the common carrier either already has an installed base of copper wiring connecting the end units, or simply does not have the cash or financing needed to bring fiber to the door. This is changing, but slowly, and it will still be years before the Integrated Services Digital Network (ISDN) plan is fully in effect.

E. MULTIMEDIA DATABASE MANAGEMENT

Multimedia data are referred to as unformatted data. This is because they consist of a list of many small items that are not normally associated with database processing, i.e. characters in the case of text, pixels in images, line segments, arcs and vectors in graphics. Because of the unformatted nature of multimedia data, being able to do more with an image than just retrieve it requires a much more complex approach than a traditional database management system (DBMS). While the problem of storing an image or a video clip and providing an address to that file in a database is relatively straightforward[Ref. 25], searching on, analyzing, or identifying the information contained in the raw data requires capabilities in interpretation normally defined as intelligence. The following quote from [Ref. 26], pp. 2-3 describes this problem well:

> The fundamental difficulty in handling multimedia lies in the problem of handling the rich semantics that is contained in the multimedia data. In traditional DBMS, data is always formatted. The semantics that can be associated with the formatted data is very restrictive. For example, if the attribute is age with the unit to be year, then a storage of 34 in the data for this attribute can mean only 34 years of age, and nothing more....

> Unfortunately multimedia data is intrinsically tied to a very rich semantics....To illustrate such a difficulty, one only need to look at a simple image of ships. Given such a picture, how are we to know what kind of ships are there? Are they destroyers? cruisers? aircraft carriers? passenger ships? freighters? oil tankers? or whatever?

The authors of [Ref. 26] go on to describe the way a person will interpret queries posed on images. A human mind registers all of its experiences and acquired information into an intricate linkage of cross-references. Every element of a visual image will trigger a connection to some chain of references which will be integrated and analyzed to provide a final evaluation of the image. This free-form relationship of data is one aspect of intelligence that computer scientists are trying to assimilate into Artificial Intelligence research.

Without the intelligence equated to visual recognition, a multimedia DBMS will necessarily be restricted to an analysis on the description of the image entered with the image. Therefore, each image will be represented by three parts: registration data, description data, and raw data. Registration data are meta-data that defines how the device will display the raw data, for example, color intensity and the colormap for an image. Description data relate to the image content, and are inherently redundant, because they simply use words entered by the user to describe what is already in the raw data, for example, "a battleship docked at San Diego Harbor". This part of the data will be used for content search with multimedia data. Raw data are bit strings of the actual data of the record, for example, a bitmap of an image.

V. MULTIMEDIA IN THE FUTURE

A. FUTURE TRENDS

Based on the rapid progress and development of desktop computing in the last decade, it would be easy to make a very simplistic prediction about multimedia and just say "*More of the same, only better: more specialized hardware, more software applications, more integration with existing systems, and especially more colors, sound, motion and FLASH!*". While true, that statement does not introduce anything new. In recent years, every single aspect of computing has been greatly improved upon. Components are smaller and cheaper. Processors are more powerful. Memory storage devices pack more data into smaller spaces with faster access times. Displays are brighter, sharper, and have more colors, and on and on--ad infinitum. There is no doubt that multimedia will continue this trend. Just looking at the multimedia products available now as compared to two years ago should be convincing. So, what can be expected?

The general direction of multimedia advancement is toward simpler, easier, integrated systems. Jack Kuehler, president of IBM Corporation, stated at the Comdex/Fall 1991 convention that "...we must significantly improve ease of use and ease of programming..." and that "...we need to bring the rich function of work stations to portable and pocket-sized systems." And, in a final comment, he stated that

the industry "...must search breakthroughs in natural interfaces...."[Ref. 27] to make using computers as natural as speaking to a friend.

1. User Interfaces

If we free our imaginations from current technological limitations, we can envision multimedia evolving into virtual reality, a merging of all aspects of computing to provide processed information for every sense, perhaps as convincing as the holograms portrayed in popular science fiction shows[15] (we can even conceive of smell and taste dimensions). In the much closer future however, we might foresee multimedia user interfaces (MMUI) replacing even graphical user interfaces (GUI) that are so popular now, with touch-screen and voice inputs interacting with full audio-visual displays.

The MMUI concept is by no means a pipe dream; IBM has already introduced an inexpensive product called TouchSelect that can be added to their PS/2 systems for a three-dimensional touch-screen input. Voice input devices--such as Articulate System's Voice Navigator for the Mac--are also readily available. All that is needed is for some enterprising programmer to write an audio-visual type user

[15]Sony Corporation demonstrated a holographic moving picture CD system at the Japan Electronics Show in Tokyo at the end of 1991. At the show Sony gave a short (10 second) demonstration of a chicken laying an egg which then hatched and the chick matured and laid its own egg. The single primary image was about 1" high and focused about 18" from the disc, with secondary images up to about 10" from the primary. Images can be either projected directly or transmitted on fiber optic cable to remote locations. Although Sony claims no immediate plans for commercial production, they did report that costs for manufacturing the holographic discs could run less than $1 each.

interface around these products within the Microsoft Windows multimedia extensions, OS/2 2.0, or Apple's Quicktime environments. The obvious benefits to a MMUI would be to make a computer system much more user-friendly and more intuitive in operating procedures. Government sponsored multimedia kiosks discussed in Chapter 2 or commercial applications such as the paint color-matching stations demonstrate how easy this type of system can be to operate. Of course a MMUI has the same drawbacks of the GUI with respect to dramatic increases in the supporting operating system's complexity and size.

2. Office Managerial Tools

The current crop of Executive Information Systems (EIS) are combining a wide range of information sources into a single service for upper level management. In addition to access to corporate Management Information Systems (MIS) and specialized Decision Support Systems (DSS), many systems include analog pass-through of video signals in order to put a window of television into a computer display screen, (nominally for news channels--like CNN, or for stock market activity, or other such information broadcasts the executive needs frequent access to). This window can also allow input from closed circuit, in-house transmissions. Soon, though, applications are expected to incorporate videophone or teleconferencing on the same integrated system. Also, when ISDN becomes a reality, these signals will likely come across the same connection. When these services are initially adopted in an office, it is likely that they will be first made available to upper management only. As

their use becomes more common and readily accepted they may rapidly become a part of mainstream office life.

Popular presentation graphics programs which have already computerized flip charts and overhead transparencies, have become one of the more common office computer tools. They may soon include the capabilities of incorporating video sequences, adding animation, or just capturing and converting video images into still images for use in a presentation. Additionally, they may be able to add synchronized sound to further spice up a presentation.

Government agencies, or any organization operating on a tight budget, have undoubtedly seen a reduction in the need for (or at least in the use of) secretarial help caused by the increased use of word processing, spreadsheets, and E-mail programs by managerial staff themselves. This trend should get an extra boost from the introduction of compound documents into these programs. It can be expected that any manager who is exposed to this type of program where voice comments or video segments can be appended to a document will immediately see the benefit of being able to give handling directions about a specific document to staff members without them getting lost or garbled en route, and without having to type them out by hand. Personnel managers will be able to append videotaped interviews to personnel files. Law enforcement or intelligence agents will be able to connect statements, analyses, interviews, etc all in the same file. An example of the move in this direction is demonstrated by the widespread acceptance of scanners which have already allowed many work environments to finally digitize and electronically file photographs and

other hardcopy items that until recently have continued to require large, physical files. So, a rapid introduction and development of many compound document applications can be counted on.

Image database programs are already available, and more are being written for use with graphics workstations or with OS/2 2.0, Windows multimedia extensions, or Quick Time. Eventually research in artificial intelligence and DBMS may demonstrate that raw data associated with images can be interpreted directly by a DBMS. This negates the need for the user to enter descriptive data along with images, and allows for a much richer interaction with all types of visual data.

3. Hardware

Multimedia at present is very hardware intensive, and will probably continue to be so for some time to come. As a result, virtually every computer hardware developer has introduced new multimedia-related products and there are many more to come. The recent consumer launch of Compact Disc-Interactive (CD-I)[16] has sparked a sudden upsurge in the release of multimedia-related consumer items, and the Comdex/Fall 1991 conference in Las Vegas, Nevada provided a showcase for dozens of other companies to display or announce their new multimedia products.

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[16]The official consumer launch of CD-I was on 16 October 1991, in the Ed Sullivan Theater in New York, New York, followed shortly after by the CD-I One Conference in Los Angeles, California, 31 October-1 November 1991.

All of this is happening now, but the near future should also include:

- Incorporation of multimedia capabilities on the motherboards of all desktop computers--expect audio first followed by video chipsets
- Further development and introduction of high capacity data storage devices (CD-ROM, WORM, erasable-magnetic-optical drives, etc.)
- Additional chipsets for video compression--especially with the new MPEG standards (new software will also be developed for compression to make use of new scaleable video compression algorithms that were not originally considered by the MPEG group)
- Many more integrated systems combining different aspects of multimedia such as laserdisc players for CD-audio, CD-I, videodisc, and MIDI

4. Networks

LANs are expected to grow from the 1990 figure of 1.5 million to 10 million by 1995 according to Andrew Grove, CEO Intel Corporation[Ref. 27]. Historically, these networks have been constructed around the newest available software and productivity tools. This may lead to many new multimedia applications. Multimedia applications on networks require some high cost components (especially for authoring/production tools). Cost-saving benefits of shared resources in networks will promote multimedia use within network environments. Until high-speed LANs are commonplace, an increasing number of major LAN overloads will occur caused by high data transfer needs of multimedia. In the long run however, improvements to LAN technology can be expected for increased bandwidth.

B. PLANS AND POTENTIAL USES FOR THE COAST GUARD

With a general idea of what is available now, and in which direction multimedia is expected to move, speculation on how the Coast Guard can benefit from using multimedia may be useful. This section presents a list of possibilities and dreams of what could be practical, or how the technology might be used. As with any other improvements or modifications, decisions on actually implementing these speculations should be based on valid cost/benefit analyses.

1. Video Transmission

(See the ADVICE project in Chapter 3.) This will probably be most useful in law enforcement activities--Maritime Law Enforcement (MLE) and Enforcement of Laws and Treaties (ELT)--for relaying visual data to the command centers and intelligence staff. It will undoubtedly find many other uses though, including:

- Vessel Traffic Systems--transmitting video of control areas to supplement radar and other sensor data.
- Aids to Navigation--checking the status of aids with aircraft or small, fast vessels and sending the data to the responsible station or ATON vessel prior to actually visiting the aid with the working unit.
- Search and Rescue--sending photographic data from on-scene units back to the command centers.
- Maintenance and repair on deployed units--transmitting visual information on inoperable equipment from remote locations to technical representatives.

Similarly, the relative merits of face-to-face conversations versus voice only (telephony) are still being debated, and so are the benefits of videophones. It has, however, already been proven that graphical displays in a presentation increase

the comprehension factor considerably, hence the widespread use of graphics presentation programs. This is because humans are primarily visually oriented animals, who acquire the largest percentage of sensory information through sight. Therefore, the same argument can be used to claim that being in visual contact with another individual will greatly improve the communication process. Videophones will facilitate the use of gestures and expressions which are as much a part of language as are words. Regardless of the outcome of this debate, videophones exist now. They are currently limited in availability and uses, but will undoubtedly soon become more common in general business use and more affordable than present models.

Senior officers, especially those in frequent contact with headquarters offices or outside agencies will probably be the first to use videophone capability. Eventually, every command will require access to at least one videophone console. Proponents of videophones have long predicted an eventual total conversion from voice-only telephones to videophones.

2. Image Databases

Databases that can store and access files of video or graphic images can be used for any purpose currently requiring or keeping hard copy photographic or videotape files (i.e. Law Enforcement, Marine Safety--documentation/registrations and Personnel records--ID photos). The present state of the art is practical for most of these uses, although it does require some special equipment such as digital cameras or scanners and video compression add-in boards. Further refinements in the field will

only make these databases more generally useable and attractive for universal applications.

3. Recruiting

Coast Guard recruiters are generally responsible for much more area than they can cover. Recruiting can benefit greatly from using interactive, information kiosks such as those discussed on page 5. These can either be permanent, in high recruit concentrated areas such as high-schools and colleges, or portable for events such as conventions, concerts, and regattas. Although the initial outlay would be expensive[17][Ref. 28], it should be cheaper than an additional recruiter, and easier to get authorized. Sharing these facilities with other armed services recruiting offices could further reduce costs and may be attractive to Department of Defense units facing large scale downsizing.

4. Compound Documents

Compound documents were discussed on page 37, and should prove useful in virtually every form of general office work. To be able to input audio and/or video signals will definitely improve the quality and usefulness of stored information. This

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[17]The IBM-trademarked 24-Hour City Hall kiosk consists of:
- -IBM PS/2 Model 50Z
- -20MB hard disk drive
- -InfoWindows video card
- -A Pioneer or Sony laserdisc player
- -InfoWindow Display monitor (printer and modem optional)
- -Software: PC-DOS, InfoWindows Control Program, Multimedia Shell Utility.

With a professionally produced video as part of the package, the cost of the kiosks can range from $15,000 to $20,000--depending on the configuration.

in turn would allow for better decisions that are made easier and faster, requiring the use of fewer resources.

5. Logistics

The current trend of automating the ordering process for supplies will probably continue to include multimedia aspects. Contracting offices already have access to entire sets of regulations documents on CD-ROM. Similar CD-ROM libraries of GSA catalogs can soon be expected, along with on-line, interactive ordering systems.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. MULTIMEDIA FINDINGS AND EXPECTATIONS

Multimedia computing is a natural evolution of information technology (IT). If multimedia can be considered an integration of diverse methods of presenting information, then it simply represents the current overall direction of progress for IT in general. Distinctions have blurred between formerly segregated classes of applications. Word processing programs include graphics capabilities. Spreadsheet programs create charts, and perform word processing and desk top publishing functions. Even database packages do calculations and design and print complete reports. Peripheral equipment has expanded capabilities in a similar fashion. A modem will not only connect one computer to another, but can be used as a speakerphone, a facsimile machine, or an answering machine. Some printers can be used as photocopiers. Screen output can be projected to a room-sized viewing screen. It seems only natural to expect full-motion video and sound to be added to these other characteristics. Multimedia should not be viewed as a threat to, or a radical departure from, the existing structure of information systems. It is instead an obvious stage in the evolution of a maturing technology.

Multimedia doesn't just provide a medium to turn your next business presentation into an Academy Award production, or to add flash to dry, boring statistics. It provides ways to condense large amounts of information into a format

that makes it easier for the user or audience to visualize and understand. For this reason, multimedia should not just be categorized as "gee-whiz" technology, despite the fact that many of the first multimedia applications offered are just that. Multimedia has, by necessity, been marketed first to the technophiles or more fervent computer users in order to open the market. Many multimedia products are now available such as image-databases or Image-Enable Notes (see page 30) that are generally appropriate for mainstream business use.

An information systems manager may have initially been put off by the inordinate amount of hype that accompanied the introduction of multimedia computing technology. That same manager may not consider any of the current crop of applications as being necessary now, but many aspects of multimedia are desirable for offices or operations centers. Multimedia applications should be weighed and evaluated on their own merits, without any prejudgments.

1. Where Multimedia Fits in Information Management

The adoption of IT into corporate structures has followed a steady incremental advancement. It has rapidly assimilated each new advance in technology, and its almost constantly improving status has reflected the ever-increasing importance of information in our culture. Figure 1 shows the progressive evolution of information management from its earliest stages as a service or support function with a

limited clientele to the all-pervasive, strategic-level position it holds now in most large organizations, including the Coast Guard[18].

When information technology is strategic to an organization it can be expected to play an important role in the development and growth of the organization. "Appropriately staffed, an important part of [an information technology department's] mission is to scan leading-edge technologies and make sure that the organization is aware of their existence."[Ref. 29]

The Coast Guard fits somewhere within the IRM or CIM stages described in Figure 1. At the upper management levels they have moved beyond the MIS level and are currently concerned with integrating the wide array of systems currently in place, and developing decision support systems needed to support managerial functions. Information systems managers in the Coast Guard should review multimedia features for their potential to assist in these tasks. Although the Coast Guard rarely finds it necessary to push the envelope of information technology, it is still necessary for them to be aware of the trends and developments at the leading-edge that may truly benefit the organization.

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[18]A determination for whether IT is strategic to an organization normally revolves around whether or not the job would continue to get done without it. For an organization like the Coast Guard, that has so many different primary mission areas, answering that question would be a major topic for research in and of itself. It is sufficient here to consider IT as strategic simply due to the fact that it provides at the least a major support function for each mission, and the impact of IT is factored into every key development or planning decision at the headquarters level within the Coast Guard.

Evolution of Information Management

EAM Electronic Accounting Machinery
Limited Services, financial or cost calculations, lowest level supervisor.

EDP Electronic Data Processing
Financial and operational services, batch processing, generally under Comptroller department.

ADP Automated Data Processing
Additional services being added, some on-line facilities, possibly own division but still under Comptroller department.

MIS Management Information Systems
New vertically integrated applications developed for mid-level management use. direct-access terminals everywhere, supports every other department, probably separate department.

IRM Information Resources Management
Information is considered strategic resource or at the least a business necessity, DSS's are being developed to support top management, movement to establish horizontal integration of applications across departments, department head is included in strategic policy making.

CIM Corporate Information Management
EIS's developed for continuous strategic information feeds to top management, continue horizontal integration, Information Resources chief is at vice presidential level. (There is still some debate about the distinction--if any--between IRM and CIM.)

Figure 1

It has been common for the transition from the MIS stage to the IRM stage to be accompanied by a greater number of information users becoming the actual operators of the systems. This is due in part to the increased use of microcomputers and smart terminals, but also to the more widespread acceptance of information systems by managers and the more immediate needs these individuals find for the information available to them.

It's at this point that multimedia appears to be most appropriate for mainstream computing. With its potential for presenting information directly to the

user in more flexible and informative formats, and with its potential for making computer systems more user-friendly or intuitive for the operator, the new genre of user/operators should not only accept multimedia information systems but actively seek them out.

Special purpose applications are especially likely to make use of multimedia capabilities. Education and training will likely make use of multimedia first, and will probably always make more use of interactive computing than normal business functions.

B. ANTICIPATING CHANGE

Evaluating the applicability of multimedia for the Coast Guard requires an ability to forecast general trends within an organization's information processing structure, and to understand some of the forces that foster this trend.

1. Setting the Stage

One generally accepted model that explains the growth process of information management is Richard Nolan's Six Stages of Growth[Ref. 30]. In it, Nolan identifies the key stages that most organizations pass through as they develop their information resources. Figure 2 identifies these stages and their primary characteristics.

Nolan's Six Stages of Growth

	Stage 1 Initiation	Stage 2 Contagion	Stage 3 Control	Stage 4 Integration	Stage 5 Data Administration	Stage 6 Maturity
Main Characteristic	First Application System Development	Enthusiasm/ Proliferation Incompatible and Redundant Data	User Frustration High Maintenance Costs Start User Accounts and Chargebacks Put Limits on Expansion of Systems	Retrofit Databases Start Merging Independent Systems	Beginning IRM Stable Data Models	Applications "Mirror" Information Flow
Types of Systems	Limited Financial/ Accounting	Financial and Operational	Introduction of Database Systems Some On-line Inquiry Systems	MIS/DSS Expanding Microcomputer Base and Decentralized Processing	Integrated Applications	EIS/ Strategic Systems
User's Role	"Hands Off" Operator is I/O Processor	Project Involvement	End User is directly involved with data entry and data use. End user is accountable for data quality and for value-added end use.		User is Frequently the Operator Builds Small Systems	User/ Operator/ Developer all Full Partners

Figure 2

Using this model, the Coast Guard appears to be in Stage 5, Data Administration[19]. At this point the end users are performing much of their own computing on distributed systems. They are actively involved in designing and implementing new systems, and are very interested in new analysis and decision tools. At the same time, the Information Resources department is trying to make the many different systems that already exist run as a cohesive whole. Any new hardware or

[19]A large company or government agency may have divisions simultaneously representing all stages, but viewed as a whole, most will have their IT concentrated in a single stage.

software introduced to the organization must be compatible with existing information infrastructures.

New technological advances can be said to follow a similar set of growth stages, at least including the Initiation, Contagion, Integration and Maturity stages. Multimedia technology is roughly at the Contagion stage. Multimedia has a very enthusiastic and evangelical following and has developed a strong foothold in certain specialized fields such as video production, but has yet to be widely adopted and integrated into mainstream computing.

2. Level of ADP Spending

The same model presented above also includes a representation of the normal progression of resource expenditures in information management (See Figure 3). In the Control stage, and continuing into Integration, expenditures normally level out reflecting the efforts to regulate previously ungoverned spending and acquisitions. Later, in the Data Administration stages where the Coast Guard is now, expenditures can be expected to increase again as systems are acquired or modified to improve the organization-wide information flow.

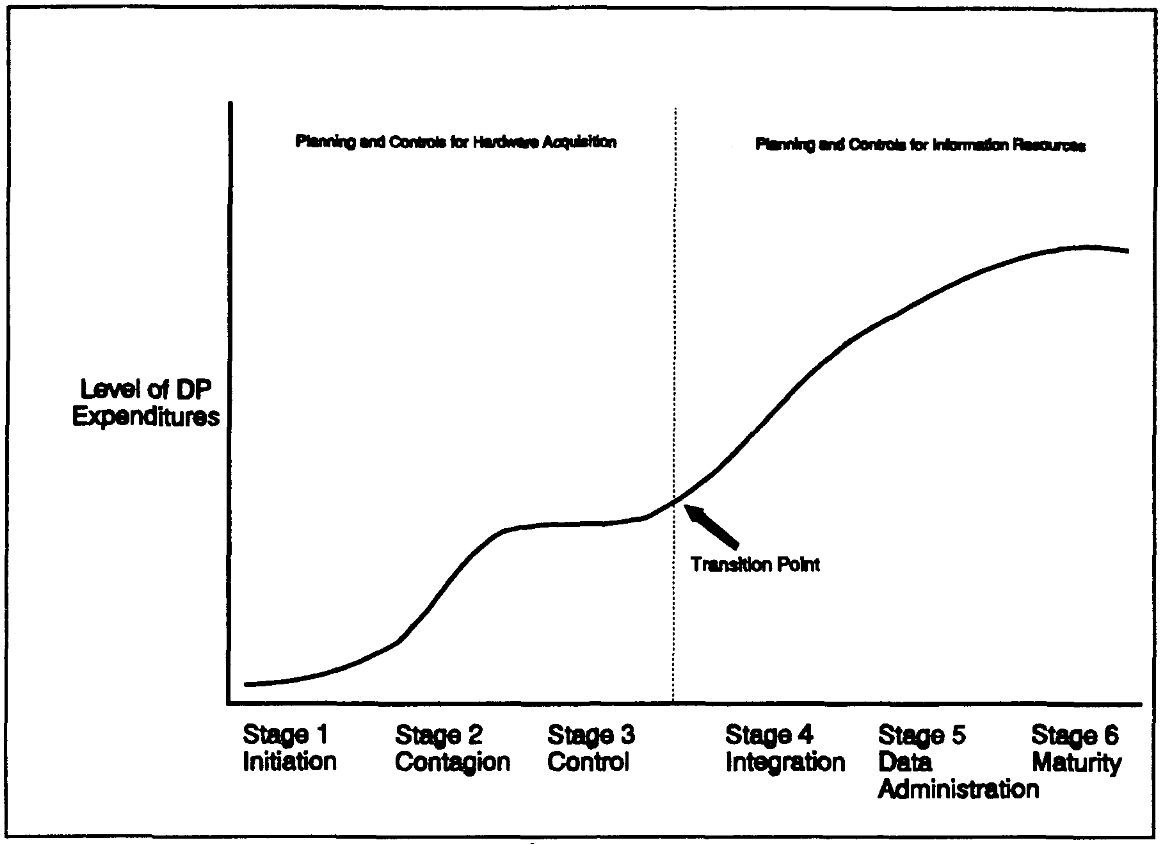

Figure 3

3. Driving Forces for Change Within the Coast Guard

As shown above, the Coast Guard is presently emphasizing horizontal integration of information systems, and providing IT support for all aspects of daily operations. This should promote a need for better and faster methods of communicating and processing existing data. It should also promote research into new ways to display or condense the information contained in that data, such as by images or audio.

A related factor influencing change will be an increased use of unstructured, non-traditional data for decision support and strategic management. This

specifically refers to graphics and images, already showing widespread use in briefings and reports.

A third factor to consider is principally subjective, but intuitively obvious to a systems manager who is aware of users' needs. This factor can be termed relative deprivation[Ref. 31]. It represents the effect when users become aware of new technology and develop a "need" for it, without any objective basis. "See what exists now. It sounds exciting. I don't have it. I want it! I have to have it--now!" This factor usually supports a rationalization for procurement requests.

The adoption of multimedia into the Coast Guard IT infrastructure will be influenced by all three of these factors. Multimedia presentations are either multisensory (i.e. visual and audio) or multi-modal (i.e. visual text and visual images), both of which improve understanding and the speed of data assimilation[Ref. 32]. The addition of sound, images and motion will stimulate the recognition of computers as wide scope communication devices. Finally, of course, is the simple appeal of the flash and glamour of being able to work with pictures, sound, and motion on a computer.

C. RECOMMENDATIONS

There are three key steps necessary for the Coast Guard IT departments to follow with all new technology. These are:

- Maintain awareness of new technologies
- Investigate and experiment with aspects that show potential benefits for the organization
- Quickly implement and distribute generally valuable developments to the field

The Coast Guard has generally followed these steps in the past.

Right now, Coast Guard IT departments should learn about multimedia and be willing to implement appropriate aspects of it when they prove useful. It is necessary to remember that multimedia is not a single technique or product, but an accumulation of different processes to transmit, process, and display data. One or more of these processes are bound to be useful to some facet of a complete information system.

Information managers need to keep an open mind toward multimedia's possibilities. They should avoid developing a prejudicial attitude against it due to the high level of media hype. Multimedia is here to stay and over the next few years will likely influence any new developments in IT. Coast Guard information managers must constantly look ahead and guess what impact new developments will have in order to prevent unwitting obsolescence.

1. Guidelines for Including Multimedia in Future Development of Information Technology

- Current standard workstation options for high definition color monitors, pointing devices and CD-ROM drives should be made part of the standard system.

Options will be needed for add-in video processing boards and audio boards until these features become standard components.

- User interfaces should be intuitive. If they cannot achieve this ideal, they should at least be *familiar*. Use the same commands/keystrokes from one application to the next. This means that a new type of user interface should supplement the existing procedures instead of replacing them. (i.e. a GUI should also have command line/function key controls, a MMUI should have both.)

- Any new operating system *must* be able to run multimedia programs, either by itself or by emulating another operating system that can.

- Operations centers should be provided with near real-time digital image data transmission capabilities to support law enforcement and search and rescue activities. This feature should also comply with secure communications guidelines for sensitive operations.

So far, these recommendations have dealt with making use of the benefits of multimedia. One potential drawback of multimedia is caused by its flashy nature. Judging by the level of attention it has generated in the trade press, it is apparent that multimedia generates a high degree of user appeal. This may in turn generate a high demand for the products before they have been completely evaluated for use in the Coast Guard. This high demand may either force distribution to the field too early or cause users to try to sidestep or circumvent control procedures for procurement.

Some features of multimedia, such as animation or full-motion video authoring capabilities may be so far outside of the needs of the standard working environment, that instead of increasing productivity they reduce it. These features may, in effect, become the desktop equivalent of CB radios. For a while everyone will want them but few will ever make good use of them. Eventually they will disappear from

mainstream use, but not until after costing enormous sums and increasing the complexity of existing systems.

To avoid this type of predicament, it is necessary to manage emergent technologies carefully from the beginning. This means to quickly recognize a potential for trouble and to take action early to counteract it. This is especially true in cases where you don't know the eventual value of a new product, but do know that it will be important and popular. An example of this situation was the introduction of personal computers. Many organizations were caught by surprise without any control systems or policies in place, while departments and individuals outside of MIS pressed harder and harder for PCs, or acquired them on their own.

The Coast Guard's headquarters units that deal with information technology need to be alert for this condition. If it arises, G-T should take the initiative and quickly institute a controlled experimental program, preferably by involving a number of field offices or units in tests and evaluations. Inform the field of what they are doing to forestall any counter-efforts. Closely observe the results and reactions of the trial sites and make an early evaluation of the general usefulness of the products and publish them to the entire Coast Guard. They should then provide applications and the training to the field as soon as practicable. Most of these steps are standard procedures, but with more emphasis on quick action and actively making the information public.

APPENDIX: MULTIMEDIA GLOSSARY

This glossary was assembled to explain many of the terms and acronyms used in the field of multimedia computing, not just in this document alone but also in many of the references used to prepare this paper. It should be useful as a general-purpose reference for anyone getting familiar with multimedia[20].

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[20]This glossary reproduces MULTIMEDIA: A Glossary published by the public affairs office of Intel Corp., 1991, which was in turn compiled from the two primary sources listed below. Some additional entries were added from the original sources.

"The Video Compression Glossary", by Craig Berkmaier, Videography, June 1991.

"Multimedia & Related Technologies: A Glossary of Terms", published by the editors of Multimedia and Videodisc Monitor, Monitor Information Services, 1991.

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A

ActionMedia™	DVI board and software product family, jointly developed with Intel and IBM.
ADPCM	**Adaptive Differential Pulse Code Modulation**. An encoding format for storing audio information in a digital format.
algorithm	In compression software refers to specific formula used to compress or decompress video.
alias	A form of image distortion associated with signal sampling. A common form of aliasing is a stair-stepped appearance along diagonal and curved lines. Motion artifacts are also created by the sampling of images; a common problem with NTSC field rate sampling is the illusion that a wagon wheel is rolling backward when it is actually moving forward.
analog	The representation of numerical values by physical variables such as voltage, current, etc. Analog devices are characterized by dials and sliding mechanisms. See also *digital*.
analog video	A video signal that represents an infinite number of smooth gradations between given video levels. By contrast, a digital video signal assigns a finite set of levels. See also *digital video*.
API	**Application Programmers Interface**. Loosely used to describe the point at which software modules or layers meet and interconnect.
asymmetrical compression	A compression system which requires more processing capability to compress an image than to decompress an image. It is typically used for the mass distribution of programs on media such as CD-ROM, where significant expense can be incurred for the

production and compression of the program, but the playback system must be low in cost.

authoring system — Software which helps developers design interactive courseware easily, without the painstaking detail of computer programming.

AVK — **Audio Video Kernel**. DVI system software designed to provide digital video and audio services across hardware and operating system environments.

B

bandwidth (Bit Rate) — Usually used in context to refer to the amount of data/unit of time that must move from one point to another - such as from CD-ROM to processor. For analog signals bandwidth is measured in terms of the frequency response of the channel--higher frequency response relates to higher image resolution. For digital signals, bandwidth is measured in terms of the **bit rate** (bps) that can pass through the channel.

C

CCITT — **Consultative Committee for Telephony and Telegraphy**. An international standards organization dedicated to creating communications protocols that will enable global compatibility for the transmission of voice, data, and video across all computing and telecommunications equipment.

CD-I — **Compact Disc-Interactive**. A compact disc format (developed by NV Philips and Sony Corporation) which provides audio, digital data, still graphics and limited motion video. A chipset from Philips, supporting the standard, is scheduled for availability in 1992.

CD-ROM	**Compact Disc-Read Only Memory**. A 4.75" laser-encoded optical memory storage medium (developed by NV Philips and Sony Corporation) with the same constant linear velocity (CLV) spiral format as compact audio discs and some videodiscs. CD-ROMs can hold about 550 megabytes of data.
CD-ROM XA	**Compact Disc-Read Only Memory eXtended Architecture**. An extension of the CD-ROM standard billed as a hybrid of CD-ROM and CD-I, and promoted by Sony and Microsoft. The extension adds ADPCM audio to permit the interleaving of sound and video data to animation and with sound synchronization. It is an essential component of Microsoft's plan for multimedia computers.
CDTV	**Commodore Dynamic Total Vision**. Consumer multimedia system from Commodore which includes CD-ROM/CD audio player, Motorola 68000 processor, 1MB RAM, and 10-key infrared remote control.
chroma, chrominance	The color portion of the video signal that includes hue and saturation information. Requires luminance, or light intensity, to make it visible.
codec	An encoder/decoder.
composite video	The complete visual wave form of the color video signal composed of chromatic and luminance picture information; blanking pedestal; field, line, and color sync pulses; and field equalizing pulses.
compressed video	A digital video image or segment that has been processed using a variety of computer algorithms and other techniques to reduce the amount of data required to accurately represent the content - and thus, the space required to store the content.
compression	The translation of data (video, audio, digital, or a combination) to a more compact form for storage or transmission.

D

DCT	**Discrete Cosine Transform.** A form of coding used in most of the current image compression systems for bit rate reduction.
delivery system	The equipment used by end users to run or "play" an interactive program.
device driver	Software that tells the computer how to talk to a peripheral device, such as a videodisc player or a printer.
digital	A method of signal representation by a set of discrete numerical values, as opposed to a continuously fluctuating current or voltage. See also *analog*.
digital video	A video signal represented by computer-readable binary numbers that describe a finite set of colors and luminance levels. See *analog video.*
digitization	Process of transforming analog *video signal into the* digital information.
DVI®	**Digital Video Interactive.** Intel's brand name for a variety of product families having to do with digital video and audio. It uses a programmable architecture chipset, allowing it to be used in a variety of symmetric and asymmetric compression modes. The current implementation can encode/decode still images using DVI modes and JPEG. Motion video is supported in the asymmetric PLV mode (for use with CD-ROM) and the symmetric RTV mode. Future versions of the DVI chipset will support the Px64 and MPEG motion video standards.

E

encoding — The process of creating a compressed file. Current product families include the 9750 video processor, ActionMedia II boards, AVK and AVSS system software, and PLV, RTV and JPEG algorithms. Future versions of the i750® video processor will support Px64 and MPEG motion video standards.

F

filtering — A process used in both analog and digital image processing to reduce bandwidth. Filters can be designed to remove information content such as high or low frequencies, for example, or to average adjacent pixels creating a new value from two or more pixels.

frame — A single, complete picture in a video or film recording. A video frame consists of two interlaced fields of either 525 lines (NTSC) or 625 lines (PAL/SECAM), running at 30 frames per second (NTSC) or 25 fps (PAL/SECAM). Film runs at 24 fps.

frame grabber — A device that "captures" and stores one complete video frame. Also known as frame storer.

I

i750® — Programmable video processor family from Intel.

IMA — **Interactive Multimedia Association**. Formed in 1991 (rooted in IVIA, Interactive Video Industry Association), industry association chartered with creating and maintaining standard specifications for multimedia systems.

interactive video — The fusion of video and computer technology. A video program and a computer program running in tandem under the control of the user. In interactive video, the user's actions, choices, and decisions genuinely affect the way in which the program unfolds.

ISV — **Independent Software Vendor**. Company which develops and sells application tools and/or software titles.

interframe coding — Compression techniques which track the differences between frames of video. Results in more compression over a range of frames than *intraframe coding.*

intraframe coding — Compression within each frame individually. Results in less compression over a range of frames than interframe coding.

J

JPEG — **Joint Photographic Experts Group**. A working committee under the auspices of the *International* Standards Organization (ISO) and the International Telephone and Telegraph Consultative Committee (CCITT) that is attempting to define a proposed universal standard for the digital compression and decompression of still images for use in computer systems. JPEG is designed to accommodate images with variable resolution and aspect ratios. The image is sequentially processed by encoding 8 X 8 pixel blocks using a lossy DCT coding algorithm followed by additional lossless coding. JPEG applications include still image storage and retrieval (imagebases); still image transmission (color fax); and a variety of image acquisition and printing products. Dedicated JPEG codec chips are now available and are being utilized as an interim solution for motion video compression while work is completed on the standard and chipsets for MPEG compression.

L

lossless compression — Ensures that the original data are exactly recoverable with no loss in image quality.

lossy compression — The original data are not completely recoverable. Although image quality may suffer, many experts believe that up to 95 percent of the data in a typical image may be discarded without a noticeable loss in apparent resolution.

luminance — Brightness; one of the three image characteristics coded in composite television (represented by the letter Y). May be measured in lux or foot-candles.

M

MCA — **Media Control Architecture**. System-level specification developed by Apple Computer for addressing various media devices (videodisc/videotape players CD players, etc.) to its Macintosh computers.

MCI — **Media Control Interface**. Platform-independent multimedia specification (published by Microsoft and others in 1990) that provides a consistent way to control devices such as CD-ROMs and video playback units.

Micro Channel — Personal computer bus architecture introduced by IBM in some of its PS/2 series microcomputers. Incompatible with original PC/AT (ISA) architecture.

MIDI — **Musical Instrument Digital Interface**. An industry-standard connection for computer control of musical instruments and devices.

MIPS — **Millions of Instructions Per Second**. Refers to a computer processor's performance.

MOPS — **Millions of Operations Per Second**. In the case of DVI technology, more MOPS translate to better video quality. Intel's video processor can perform multiple video operations per instruction, thus the MOPS rating is usually greater than the MIPS rating.

MPEG — **Motion Picture Experts Group**. A working committee under the auspices of the International Standards Organization (ISO) and the International Telephone and Telegraph Consultative Committee (CCITT) that is attempting to define standards for the digital compression and decompression of motion video/audio for use in computer systems. MPEG is designed to provide a 3 to 1 improvement over JPEG compression ratios and includes specifications for synchronized audio. Baseline MPEG coding provides a digital data rate of about 1.5 Mbit/second. This is within the range of CD-ROM delivery systems. MPEG compression is based on a combination of intraframe and interframe coding techniques. The frames between the intraframe images are coded using motion predictive techniques that allow greater compression.

multimedia — Refers to the delivery of information which combines different content formats (motion video, audio, still images, graphics, animation, text, etc.).

multimedia computing — Refers to the delivery of multimedia information delivered via computers.

N

NTSC — **National Television Systems Committee** of the Electronics Industries Association (EIA) that prepared the standard of specifications approved by the Federal Communications Commission, in December 1953, for commercial color broadcasting. NTSC is still the TV standard for the U.S. and Japan, et. al. - (See *NTSC format*).

NTSC format A color television format having 525 scan lines; a field frequency of 60 Hz; a broadcast bandwidth of 4 MHz; line frequency of 15.75 KHz; frame frequency of 1/30 of a second; and a color subcarrier frequency of 3.58 MHz. See also *PAL, SECAM.*

O

OEM **Original Equipment Manufacturer**. Company which develops, produces and sells computer and consumer hardware.

P

Px64 **Also known as CCITT Recommendation H.261.** A draft standard for motion video compression in videophone and teleconferencing applications, designed around 64 kbit/second transmission channels. P is an integer value corresponding to the number of channels available for data. Channels can be added to improve resolution or to connect multiple sites for a teleconference. The standard was created for the Integrated Services Digital Network (ISDN), which can accommodate multiple channels of 64 kbit data.

PAL format **Phase Alternation Line**. The European video standard, except for France. See also *NTSC, SECAM.*

pixel An abbreviation for picture element. the minimum raster display element, represented as a point with a specified color or intensity level. One way to measure picture resolution is by the number of pixels used to create images.

PLV **Production Level Video**. Highest quality DVI motion video compression algorithm today. Compression is achieved "off-line", (non-real-time), while playback

(decompression) is real-time (asymmetrical compression). Independent of the technology in use, off-line compression will always produce a better image quality than real-time or symmetrical compression since more time and processing power is used per frame.

Q

quantize — A step in the process of converting analog signal into a sigital signal. This step measures a sample to determine a representative numerical value that is then encoded.

(Q) factor — used with JPEG compression to adjust the degree of quantization of the compressed image. Lower Q factors provide the highest quality images. Factors in the range from 1-50 provide the greatest amount of compression in image data file size. Factors above 50 continue to reduce image quality but provide little additional reduction in file size.

R

real-time — In computing, refers to an operating mode under which data is received, processed and the results returned instantaneously.

resolution — Number of pixels per unit of area. A display with a finer grid contains more pixels and thus has a higher resolution, capable of reproducing more detail in an image.

RIFF — **Resource Interchange File Format**. Platform-independent multimedia specification (published by Microsoft and others in 1990) that allows audio, image, animation, and other multimedia elements to be stored in

a common format. See also *Media Control Interface (MCI).*

RGB — **Red-Green-Blue**. A type of computer color display output signal comprised of separately controllable red, green, and blue signals; as opposed to composite video, in which signals are combined prior to output. RGB monitors typically offer higher resolution than composite. See also *composite video.*

RTV — **Real Time Video**. On-line, symmetrical, 30 frames per second, DVI motion video compression algorithm.

S

saturated colors — Strong, bright colors (particularly reds and oranges) which do not reproduce well on video; they tend to saturate the screen with color or bleed around the edges, producing a garish, unclear image.

scalability — The ability to vary the information content of a program by changing the amount of data that is stored, transmitted or displayed. In a video image, this translates into creating larger or smaller windows of video on screens (shrinking effect).

SECAM format — "Sequential couleur a memoire" (sequential color with memory), the French color TV system also adopted in Russia. The basis of operation is the sequential recording of primary colors in alternate lines. See also *NTSC, PAL.*

SMPTE time code — An 80-bit standardization edit time code adopted by SMPTE, the Society of Motion Picture and Television Engineers. See *time code.*

subsampling — Bandwidth reduction techniques which reduce the amount of digital data used to represent an image, part of a compression process.

S-video Type of video signal used in the Hi8 and S-VHS videotape formats. It transmits luminance and color portions separately, using multiple wires, thus avoiding the NTSC encoding process and its inevitable loss of picture quality. Also known as Y/C video.

symmetrical compression A compression system which requires equal processing capability for compression and decompression of an image. this form of compression is used in applications where both compression and decompression will be utilized frequently. Examples include: still image databasing, still image transmission (color fax), video production, video mail, videophones, and videoconferencing. See *asymmetrical compression.*

T

teleconference A general term for a meeting not held in person. Usually refers to a multi-party telephone call, set up by the phone company or private source, which enables more than two callers to participate in a conversation. The growing use of video allows participants at remote locations to see, hear, and participate in proceedings, or share visual data ("video conference").

time code A frame-by-frame address code time reference recorded on the spare track of a videotape or inserted in the vertical blanking interval. It is an eight-digit number encoding time in hours, minutes, seconds, and video frames (eg: 02:04:48:26).

V

VAR **Value Added Reseller**. A company which resells hardware and software packages to developers and/or end-users.

VDRV — **Variable Data Rate Video**. In digital systems, the ability to vary the amount of data processed per frame to match image quality and transmission bandwidth requirements. DVI symmetrical and asymmetrical systems can compress video at variable data rates.

Y

YUV color system — A color encoding-scheme for natural pictures in which the luminance and chrominance are separate. The human eye is less sensitive to color variations than to intensity variations, so YUV allows the encoding of luminance (Y) information at full bandwidth and chrominance (UV) information at half bandwidth.

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